1) INTRODUCTION

A company which manages a Distribution Network is responsible for:

- Gas network design and construction.
- Commercial prospecting to increase the number of customers.
- Customer connections.
- Gas supply.
- Customer management.
- Network management and maintenance.
- Gas supply safety.

This paper will deal only with the network.

2) NETWORK DESIGN

To develop a network capable of satisfying customer needs:

- To reach an optimum (size, pressure) to deliver the quantity of gas which is targeted even in case of the breakdown of a city gate.
- To minimize the total cost (materials + laying + maintenance).
- To have a “good” safety (100% is impossible).
- To obtain a good durability.

For that, some software packages are used such as CARPATHE in France.

Distribution networks for natural gas comprise several different pressure levels:

- Primary networks between 4 and 19 bar (mainly on the town ring).
- Secondary networks at 4 bar.
- Tertiary networks at 20 mbar.
In France, the typical design of a network of a large city is:

a) a primary network (it may be meshed) and supplied by one or, better, more city gate stations.

This network has an operating pressure of 19 bar maxi. All the pipes are steel-made with a PE coating and are given cathodic protection.

Valves must be fitted at regular intervals for rapid isolation of a damaged branch.

Obviously when damaged, a branch must be rapidly isolated and depressurized while maintaining gas supply to customers.

An internal specification of GAZ de FRANCE specify that a branch must be depressurized within 30 min.

b) A secondary network at 4 bar.

Since the end of the 70’s, GAZ de FRANCE builds this network with PE pipes assembled by electrofusion, for OD (outside diameter) below 200 mm and by butt fusion for large OD.

In France we are used to :

- design a non-meshed secondary network.
- Install a valve at the beginning of a branch.
- Have 300 to 600 clients on one branch.
- Have a by-pass at the connecting point of the main network and a branch supplying an industrial client.
- Install blow down system between two valves.

c) No tertiary network because a regulator 4 bar/20 mbar is installed, mainly outside the houses in a cabinet (made of plastic).

So after the regulator there is a meter and then the domestic installation which is mainly on copper in FRANCE, excepted in the eastern regions where steel is used.

For a medium or small city there is no primary network and all the network is at 4 bar.

Some distribution networks are remote-controlled and are monitored and operated from a central control room.

3) PIPE LAYING

At the end of the 70’s, GAZ de FRANCE decided to use PE to build its gas distribution networks.

To day the new networks are all built with PE.
The Table 1 below show the importance of PE.

**Table 1 : Total length of distribution networks of GAZ de FRANCE (in 1 000 km)**

<table>
<thead>
<tr>
<th>MaterialYears</th>
<th>Miscelle neous</th>
<th>Gray cast iron</th>
<th>Ductile cast iron</th>
<th>Steel</th>
<th>PE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>4.4</td>
<td>29.2</td>
<td>5.1</td>
<td>42.7</td>
<td>1.5</td>
<td>82.9</td>
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<td>1985</td>
<td>4.0</td>
<td>23.7</td>
<td>7.0</td>
<td>50.4</td>
<td>12.7</td>
<td>97.8</td>
</tr>
<tr>
<td>1990</td>
<td>3.4</td>
<td>17.1</td>
<td>7.6</td>
<td>52.3</td>
<td>33.5</td>
<td>113.9</td>
</tr>
<tr>
<td>1995</td>
<td>3.3</td>
<td>9.5</td>
<td>7.1</td>
<td>52.3</td>
<td>58.7</td>
<td>130.9</td>
</tr>
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<td>1998</td>
<td>2.6</td>
<td>6.9</td>
<td>6.8</td>
<td>53.1</td>
<td>73.2</td>
<td>142.6</td>
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<tr>
<td>1999</td>
<td>2.9</td>
<td>6.2</td>
<td>6.8</td>
<td>53.2</td>
<td>78.1</td>
<td>147.2</td>
</tr>
<tr>
<td>2000</td>
<td>2.5</td>
<td>5.5</td>
<td>6.7</td>
<td>53.3</td>
<td>84.3</td>
<td>152.3</td>
</tr>
</tbody>
</table>

The inherent properties of PE (low weight, high flexibility, long term strength) make it ideal for laying in long lengths that can be joined together by electrofusion, a technique that is both fast and inexpensive.

But we must be aware that the PE system is safe only if:

a) The resin complies with ISO standards.
b) The pipe manufacturer is skilled and serious (no re-use of reprocessable PE to manufacture PE gas pipe).
c) The welding on field is made with appropriate materials and tools.

For electrofusion, it is very important to use only electrofusion fittings with barcodes and automatic welding machines because there are many manufacturers of fittings having different welding parameters. The bar code eliminates all the errors of parameters.

For butt fusion it is important to use fully automatized or semi automatized machine to improve the reliability of the junction.

d) The welding on field is made with skilled operators.
PE electrofusion (or butt fusion) assembly technique is quite simple but its reliability is only based on strict respect for the implementation operating modes.

All GAZ de FRANCE employees, and their subcontractors responsible for implementation of PE, receive initial training followed by periodic refresher training. They all must have received a qualification certificate issued on the basis of a specification drawn up by the FRENCH GAS ASSOCIATION.

4) PIPE REPLACEMENT AND MAINTENANCE

It is often necessary to replace an old network when the gas distributed moved from manufactured gas to natural gas.

Network distributing manufactured gas was often made of cast iron.

There were some leakages but the tar deposed inside the pipes ensured a satisfying safety.

But, natural gas is dry and clean. So, soon or late, the joints between the pipes on cast iron become dry and no more gastight. Leakages of gas occur.

It is consequently very important to be prepared to the arrival of natural gas.

To ensure the safety of an old cast iron gas network, different techniques exist :

- The laying of a new network. Obviously it is an expensive solution.
- The closefit lining which consist to insert a thin hose inside the pipe and to stick it to the internal surface of the pipe : interesting solution for an increase of the duration of the service life of the network for some years (less than 10 years) but often expensive.
- the lining which consist to insert a PE pipe inside the old network. As there is necessary a reduction of the diameter of the new pipe, it is a good solution for a new 4 bar operating network. It is a very cheap technique. This is the technique currently used in France to replace the old network.

There is also a technique called “gas conditioning”. It consists to spray in natural gas some solvents or water vapor so that the joints remain gastight. It is necessary to design carefully the conditioning units and the locations of these units.

This technique was widely used in France during the 60’s because, for a reasonable cost, it authorized a long term planification for the replacement of the old network.

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In addition, for a general policy of maintenance, it is important:

- to ensure that the network is not damaged by a third party. For instance it is very important to patrol and to have a surveillance of third-party work sites close to gas network.
- To maintain all active structures, such as governors, valves, meters, cathodic protection, odorization in good working order.
- To perform regular leakage surveys and repair dangerous leaks detected. The leakage surveys can be performed on foot (3 to 4 km per day) or by vehicle (50 to 60 km per day).

The two techniques are in use in GAZ de FRANCE:

Complete survey by vehicle one or twice per year and precise survey, when necessary, by foot.

5) CONCLUSION

The distribution of natural gas is different than the manufactured gas distribution.

Natural gas can be distributed at medium pressure (4 bar) and this authorizes modern techniques both cheap and reliable.

But natural gas remains a very dangerous gas because of its ability to explode.

So it is necessary to use “good” materials, skilled workers, to have a good odorization of the gas and a strict policy of maintenance.

If all these precautions have been taken, the gas company will have an important development because all the customers will want to consume natural gas.